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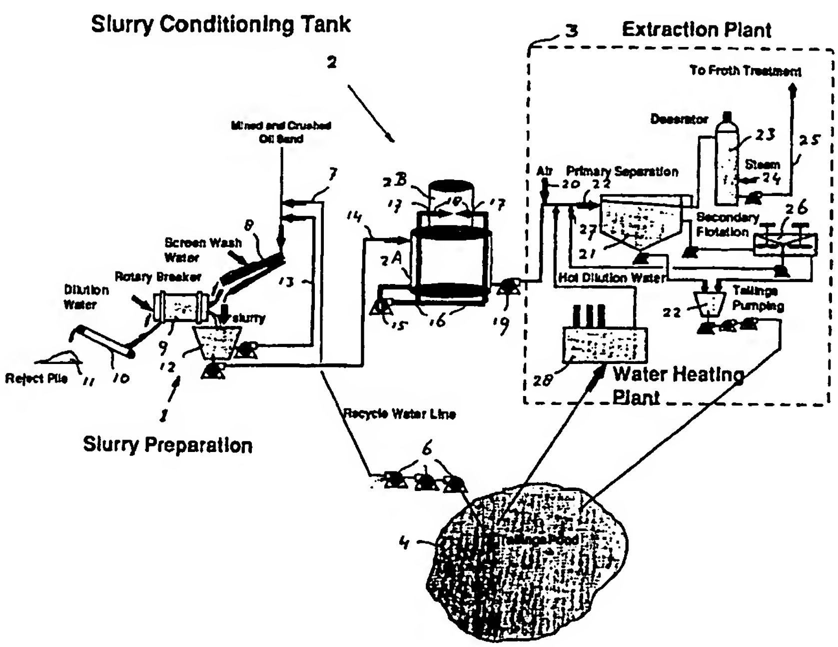
# (54) METHODE DE CONDITIONNEMENT D'UNE BOUE CONSTITUEE D'EAU ET DE SABLE BITUMINEUX, ET APPAREIL CONNEXE

# (54) METHOD AND APPARATUS FOR CONDITIONING AN OIL SAND AND WATER SLURRY




(57) Conditionnement d'un mélange de sable bitumineux et de boue liquide dans un réservoir de conditionnement non rotatif dans lequel le mélange est remué, ce qui a pour effet de désagréger les mottes de sable bitumineux et d'induire les contraintes mécaniques nécessaires pour la séparation du sable bitumineux. La boue liquide peut être remuée par recirculation dans le réservoir, à l'aide d'une roue à aubes, ou d'armatures mobiles ou vibrantes.

(57) An oil sand and water slurry is conditioned in a non-rotating conditioning tank in which the slurry is agitated thereby breaking oil sand lumps that may be present in the slurry and adding shear stress required to ablate the oil sand. The slurry may be agitated by recirculating slurry through the tank, by rotating impellers and/or by moving or vibrating armatures.

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METHOD AND APPARATUS FOR CONDITIONING AN OIL SAND AND WATER SLURRY

The invention relates to a method and system for conditioning an oil sand and water slurry.

Various systems have been proposed for the extraction of bitumen from oil sand, incorporating steps in which the oil sand is mined, conditioned, conveyed to an extraction plant and separated into tailings and a bitumen froth. The conditioning step normally involves mixing the oil sand with water and agitating the oil sand/water mixture in conditioning drums or pipelines. The performance of the conditioning step can be modified by varying the intensity of the agitation or the temperature of the oil sand and water mixture or by adding certain chemicals. The separation normally mainly takes place by gravity settling in separation vessels downstream of the conditioning step. The separation step is directed to reducing the bitumen content in the tailings and the water and minerals content in the bitumen froth. The tailings may be treated further and disposed, either as a dewatered or dry tailings or as a slurry to a tailings pond or other settling means. The bitumen froth is further treated to separate the de-mineralized bitumen from the water.

The conditioning step, when considered in greater detail, is directed to attaining the following objectives:

rendering the viscous bitumen more amenable to separation from the sand grains;

dispersing the bitumen from the solids and into the water;

causing the normally present lumps of oil sand to break down, or ablate, to a sufficiently small size to avoid them being lost to rock reject; and

entraining air bubbles in the slurry.

Some coalescence of bitumen particles may occur in the conditioning step so that they attach to the air bubbles to form a bitumen froth that is separable from the water and solids.

The conditioning step is normally carried out by using large rotating conditioning drums or aqueous slurry pipelines. The use of rotating conditioning drums is described in US patent specification No. 5,480,566, which is directed to a conditioning drum having internal spiral ribbons designed to condition oil sand with water in a counter current mode. The use of aqueous slurry pipelines to simultaneously transport and condition oil sand is described in US patent specification No. 5,264,118.

The use of rotating conditioning drums is sub-optimal for the following reasons:

generally a large size of rotating drum is required which results in construction and operating complexities and costs;

operating problems inherent in large rotating equipment;

inflexibility of operation;

consequences of a breakdown; and

difficulty achieving the necessary ablation.

The use of aqueous slurry pipelines avoids some of the problems associated with the use of rotating conditioning drums but requires the slurry preparation site to be geographically located at a sufficient distance from the extraction plant to allow the necessary conditioning to take place. This is not practical for a mine and extraction plant that are each located in close proximity to the other. Additionally, the use of aqueous slurry pipelines may not be preferred if a transportation

means is available that is more attractive than is pipeline transport.

An object of the present invention is to provide a method and apparatus for conditioning an oil sand and water slurry which do not require the use of a large rotating drum or a lengthy pipeline system and which are able to condition the oil sand slurry in an efficient and cost-effective manner.

The method according to the invention comprises pumping the slurry from a slurry preparation plant into a non-rotating slurry conditioning tank in which the slurry is agitated by agitation means, and feeding the conditioned slurry from the tank to an oil extraction plant.

Preferably, the agitation means extract slurry from a lower region of the tank and recirculate it into an upper region of the tank, which may be accomplished by pumping slurry through a number of recirculation pipes that each have an inlet opening passing through the wall of the lower region of the tank and have an outlet opening debouching into the upper region of the tank.

Preferably, the amount of recirculation is controlled such that the average residence time of the slurry in the tank exceeds a pre-set level and is sufficiently long to condition the slurry by breaking lumps of oil sand and adding shear stress that ablates the oil sand.

It is also preferred that the lower region of the conditioning tank has a larger average internal width than the upper region of the tank. Suitably, the upper and lower regions of the conditioning tank have substantially co-axial cylindrical side walls, the lower region has a larger internal diameter than the upper region of the tank and the outlet openings of the recirculation pipes debouch in a radial sense into the upper region of the tank such that in use streams of

recirculated slurry from different outlet openings impinge on each other.

The slurry conditioning tank of the apparatus according to the invention can be located between and in close proximity to a slurry preparation plant and an oil extraction plant which is designed to handle the oil separation, tailing and froth treatment steps.

The residence time of the slurry in the conditioning tank and the temperature of the slurry within the tank and addition of any chemicals can be controlled to optimize the degree of conditioning that occurs.

The invention will now be described in more detail with reference to the accompanying drawing which shows schematically an oil sand production system in which the method and apparatus according to the invention are used.

The production system comprises an oil sand and water slurry preparation plant 1, a slurry conditioning tank 2 according to the invention and an oil extraction plant 3 in which the oil is separated from the conditioned slurry and from where the residual tailings are disposed into a tailings pond 4.

In the drawing arrow 5 represents an oil sand supply line containing a stream of mined and crushed oil sand which is, as illustrated by arrow 7, mixed with water that is retrieved from the tailings pond 4 by pumps 6. The oil and water slurry is fed to a screen 8 having a sieve opening size of approximately 5 cm from where rock and oil sand lumps having a size that exceeds 5 cm are fed to a rotary breaker 9. Large lumps of rock and oil sand that are not broken by the breaker to a size smaller than about 5 cm are transported via a conveyor belt 10 to a reject pile 11. A slurry containing solid particles and oil sand lumps of a size smaller than approximately 5 cm is fed from the screen 8 and rotary breaker 9 into a slurry hopper 12. Optionally, as illustrated by arrow 13, at least part of the slurry may be recycled into the

mined oil sand supply line 5 and the remaining part of the slurry is pumped into the slurry conditioning tank 2 as illustrated by arrow 14.

The slurry conditioning tank 2 comprises cylindrical co-axial lower and upper regions 2A and 2B, respectively, and the lower region 2B has a larger internal diameter than the upper region 2B.

At least part of the oil sand slurry is recirculated through the conditioning tank 2 by extracting slurry from the lower region 2A and pumping it into the upper region 2B of the tank by means of a recirculation pump 15 and a slurry recirculation conduit system 16. The recirculation conduit system 16 comprises two slurry outlet openings 17 that pass in a radial sense and at opposite sides through the side wall of the upper region 2B of the tank such that the slurry streams injected through these openings impinge on each other as illustrated by arrows 18. The pump rate of the slurry recirculation pump 15 is controlled such that the average residence time of the slurry in the conditioning tank is sufficiently long to condition the slurry by breaking lumps of oil sand and adding shear stress required to ablate the oil sand.

A pump 19 extracts the conditioned slurry from the lower region of the conditioning tank 2 and feeds it to the oil extraction plant 3.

In the oil extraction plant 3 air is injected into the slurry as illustrated by arrow 20 and the aerated slurry is pumped into a primary gravity separation vessel 21 as illustrated by arrow 22.

In the separation vessel 21 water and sand will sink to the bottom of the vessel from where it is pumped towards a tailings preparation unit 22. The tailings are subsequently pumped into the tailings pond 4.

Oil and/or bitumen particles are skimmed from the top of the separation vessel 21 and pumped into a deaerator

23. In the deaerator 23 the oil and/or bitumen particles are mixed with steam 24 and, as illustrated by arrow 25, the heated mixture is subsequently pumped towards a froth treatment unit (not shown) for further processing.

Part of the oil, sand and water slurry is pumped from the region just below the top of the separation vessel 21 into a secondary flotation unit 26. The oil rich part of the slurry is extracted from the top of the flotation unit 26 and reinjected into the primary separation vessel 21 as illustrated by arrow 27. The remaining part of the slurry is extracted from the bottom of the secondary flotation unit 26 and fed to the tailings preparation unit 22.

The extraction plant 3 further comprises a water heating plant 28 which extracts water from the tailings pond 4 and injects, as illustrated by arrow 29, the heated water into the slurry stream 22 that is fed into the primary separation vessel 21.

The use of the conditioning tank 2 according to the invention provides an opportunity to encourage coalescence of oil or bitumen particles near the top of the lower region 2A of the tank. This will permit selective removal (not shown) of coalesced oil or bitumen floating near the top of the lower region 2A of the tank and then transportation (not shown) of the removed oil and/or bitumen froth directly into the secondary flotation 26 of the extraction plant 3, by-passing the primary separation vessel 21.

It will be understood that instead of or in addition to the slurry recirculation conduit system 16 depicted in the drawing other agitation means may be used to agitate the slurry in the conditioning tank. Suitable alternative agitation means are rotatable impellers and moving or vibrating armatures.

C L A I M S

1. A method for conditioning an oil sand and water slurry, the method comprising pumping the slurry from a slurry preparation plant into a non-rotating slurry conditioning tank in which the slurry is agitated by agitation means and feeding the conditioned slurry from the tank to an oil extraction plant.

2. The method of claim 1, wherein the slurry is agitated by agitation means which extract slurry from a lower region of the conditioning tank and recirculate it into an upper region of the conditioning tank.

3. The method of claim 2, wherein the agitation means recirculate slurry through the conditioning tank by pumping slurry through a number of recirculation pipes that each have an inlet opening passing through the wall of the lower region of the tank and have an outlet opening passing through the wall of the upper region of the tank.

4. The method of claim 2 or 3, wherein the lower region of the tank has a larger average internal width than the upper region of the tank.

5. The method of claim 4, wherein the lower and upper regions of the tank have substantially co-axial cylindrical side walls and the outlet openings of the recirculation pipes direct the recirculated slurry in a substantially radial sense into the upper region of the tank.

6. The method of claim 5, wherein a plurality of outlet openings debouch into said upper region of the tank such that the streams of recirculated slurry from said outlet openings impinge on each other.

7. The method of any one of claims 2 to 6, wherein the amount of recirculation is controlled such that the

average residence time of the slurry in the tank exceeds a pre-set level and is sufficiently long to condition the slurry by breaking lumps of oil sand and adding shear stress that ablates the oil sand.

8. An apparatus for conditioning an oil sand and water slurry, the apparatus comprising a non-rotating slurry conditioning tank having an inlet for receiving an oil sand and water slurry from a slurry preparation plant, an outlet for feeding the conditioned slurry to an oil extraction plant and agitation means for agitation slurry in the slurry conditioning tank.

9. The apparatus of claim 8, wherein the agitation means comprise a system for recirculating slurry through the tank by extracting slurry from a lower region of the tank and pumping it into an upper region of the tank.

10. The apparatus of claim 9, wherein the slurry recirculation system comprises a number of recirculation pipes that each have an inlet opening passing through the wall of a lower region of the tank and an outlet opening passing through the wall of an upper region of the tank.

11. The apparatus of claim 10, wherein the upper and lower regions of the tank have substantially co-axial cylindrical side walls, the lower region has a larger internal diameter than the upper region of the tank and the outlet openings of the recirculation pipes pass in a radial sense through the cylindrical side wall of the upper region of the tank such that in use streams of recirculated slurry from different outlet openings impinge on each other.

12. The apparatus of claim 8, wherein the agitation means comprise rotatable impellers.

13. The apparatus of claim 8, wherein the agitation means comprise movable or vibratable armatures.



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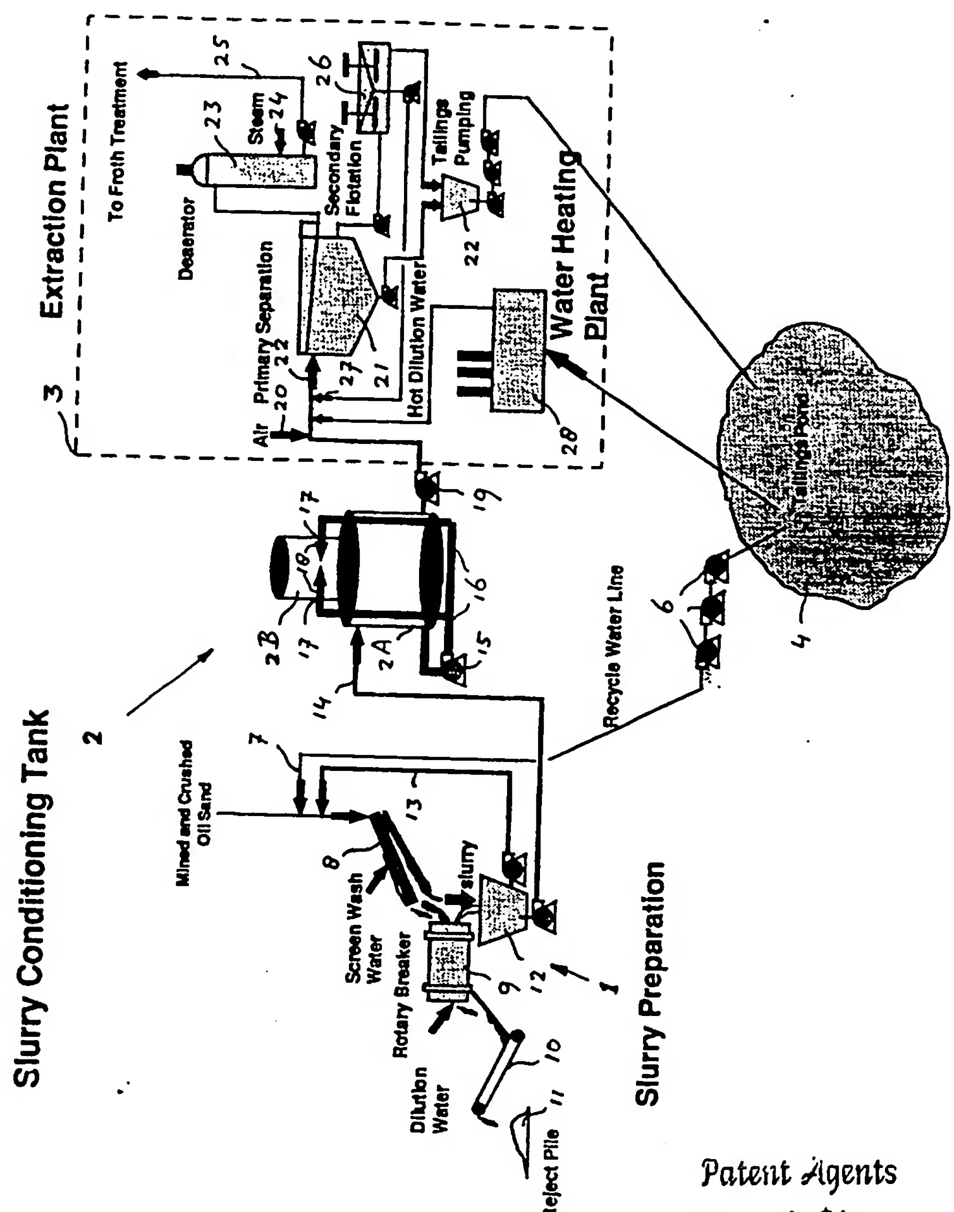


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